CHAPTER 5

Work, Energy and Power

Work Done

1. A force F = 20 + 10y acts on a particle in y direction where F is in newton and y in meter. Work done by this force to move the particle from y = 0 to y = 1 m is *(2019)*

a. 30 J b. 5 J
c. 25 J d. 20 J

2. A particle moves from a point $\left(-2\hat{i}+5\hat{j}\right)$ to $\left(4\hat{j}+3\hat{k}\right)$ when a force of $\left(4\hat{i}+3\hat{j}\right)$ N is applied. How much work has been done by the force? *(2016 - II)*

a. 5 J b. 2 J
c. 8 J d. 11 J

3. A uniform force of $\left(3\hat{i}+\hat{j}\right)$ newton acts on a particle of mass 2 kg. Hence the particle is displaced from position $\left(2\hat{i}+\hat{k}\right)$ metre to position $\left(4\hat{i}+3\hat{j}-\hat{k}\right)$ metre. The work done by the force on the particle is: *(2013)*

a. 15 J b. 9 J
c. 6 J d. 13 J

Energy and Conservation of Mechanical Energy

4. A particle is released from height S from the surface of the Earth. At a certain height its kinetic energy is three times its potential energy. The height from the surface of earth and the speed of the particle at that instant are respectively: *(2021)*

a. $\frac{S}{4}, \frac{\sqrt{3gS}}{2}$ b. $\frac{S}{2}, \frac{\sqrt{3gS}}{2}$
c. $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$ d. $\frac{S}{4}, \frac{3gS}{2}$

5. A body of mass (4m) is lying in x-y plane at rest. It suddenly explodes into three pieces. Two pieces each of mass (m) move perpendicular to each other with equal speeds (v). The total kinetic energy generated due to explosion is: *(2014)*

a. mv^2 b. $3/2mv^2$
c. $2\ mv^2$ d. $4\ mv^2$

6. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with 8 ms^{-1} speed. If the third part flies off with 4 ms^{-1} speed, then its mass is: *(2013, 2009)*

a. 17 kg b. 3 kg
c. 5 kg d. 7 kg

Spring

7. Two similar springs P and Q have spring constants K_P and K_Q such that $K_P > K_Q$. They stretched first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as in case (a) and case (b), respectively: *(2015)*

a. $W_P = W_Q$; $W_P = W_Q$
b. $W_P > W_Q$; $W_Q > W_P$
c. $W_P < W_Q$; $W_Q < W_P$
d. $W_P = W_Q$; $W_P > W_Q$

Work Energy Theorem

8. Consider a drop of rain water having mass 1 g falling from a height of 1 km. It hits the ground with a speed of 50 m/s. Take 'g' constant with a value 10 m/s^2. The work done by the (i) gravitational force and the (ii) resistive force of air is: *(2017-Delhi)*

a. (i) 1.25 J (ii) –8.25 J
b. (i) 100 J (ii) 8.75 J
c. (i) 10 J (ii) –8.75 J
d. (i) –10 J (ii) –8.25 J

9. A bullet of mass 10 g moving horizontally with a velocity of 400 ms^{-1} strikes a wooden block of mass 2 kg which is suspended by a light inextensible string of length 5 m. As a result, the center of gravity of the block is found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges out horizontally from the block will be: *(2016 - II)*

a. 120 ms^{-1} b. 160 ms^{-1}
c. 100 ms^{-1} d. 80 ms^{-1}

10. A block of mass 10 kg moving in x direction with a constant speed of 10 ms^{-1}, is subjected to a retarding force F = –0.1x J/m during its travel from x = 20 m to 30 m. Its final K.E. will be: *(2015)*

a. 450 J b. 275 J
c. 250 J d. 475 J

Power

11. An electric lift with a maximum load of 2000 kg (lift + passengers) is moving up with a constant speed of 1.5ms^{-1}. The frictional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is: (g = 10 ms^{-2}) *(2022)*

a. 23500 b. 23000
c. 20000 d. 34500

12. The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is: *(2022)*

a. 1×10^5 J b. 36×10^7 J
c. 36×10^4 J d. 36×10^5 J

13. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional force are 10% of the input energy. How much power is generated by the turbine? (g = 10 m/s^2) *(2021, 2008)*

a. 8.1 kW b. 12.3 kW
c. 7.0 kW d. 10.2 kW

14. A body of mass 1 kg begins to move under the action of a time dependent force $F = (2t\hat{i} + 3t^2\hat{j})$ N, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis. What power will be developed by the force at the time t? *(2016 - I)*

a. $(2t^2 + 3t^2)$W
b. $(2t^2 + 4t^4)$W
c. $(2t^3 + 4t^4)$W
d. $(2t^3 + 3t^5)$W

15. A particle of mass m is driven by a machine that delivers a constant power k watts. If the particle starts from rest the force on the particle at time t is: *(2015)*

a. $\sqrt{mk}\,t^{\frac{-1}{2}}$ b. $\sqrt{2mk}\,t^{\frac{-1}{2}}$
c. $\frac{1}{2}\sqrt{mk}\,t^{\frac{-1}{2}}$ d. $\sqrt{\frac{mk}{2}}\,t^{\frac{-1}{2}}$

16. The heart of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6×10^3 kg/m^3 and g = 10m/s^2, then the power of heart in watt is: *(2015 Re)*

a. 1.50 b. 1.70
c. 2.35 d. 3.0

Vertical Circle

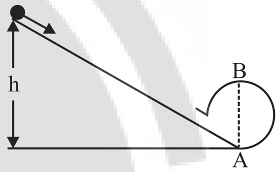
17. A point mass 'm' is moved in a vertical circle of radius 'r' with the help of a string. The velocity of the mass is $\sqrt{7gr}$ at the lowest point. The tension in the string at the lowest point is *(2020-Covid)*

a. 7 mg b. 8 mg
c. 1 mg d. 6 mg

18. A mass m is attached to a thin wire and whirled in a vertical circle. The wire is most likely to break when: *(2019)*

a. The mass is at the highest point
b. The wire is horizontal
c. The mass is at the lowest point
d. Inclined at an angle of 60° from vertical

19. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter AB = D. The height h is equal to: *(2018)*



a. $\frac{7}{5}D$ b. D
c. $\frac{3}{2}D$ d. $\frac{5}{4}D$

20. What is the minimum velocity with which a body of mass m must enter a vertical loop of radius R so that it can complete the loop? *(2016 - I)*

a. $\sqrt{gR}$ b. $\sqrt{2gR}$
c. $\sqrt{3gR}$ d. $\sqrt{5gR}$

21. A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion? *(2016 - I)*

a. 0.1 m/s^2 b. 0.15 m/s^2
c. 0.18 m/s^2 d. 0.2 m/s^2

Collision

22. Body A of mass 4m moving with speed u collides with another body B of mass 2m, at rest. The collision is head on and elastic in nature. After the collision the fraction of energy lost by the colliding body A is: *(2019)*

a. $\frac{1}{9}$ b. $\frac{8}{9}$
c. $\frac{4}{9}$ d. $\frac{5}{9}$

23. A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of restitution(e) will be *(2018)*

a. 0.8
b. 0.25
c. 0.5
d. 0.4

24. Two identical balls A and B having velocities of 0.5 m/s and –0.3 m/s respectively collide elastically in one dimension. The velocities of B and A after the collision respectively will be: *(2016, 1998, 1994, 1991)*

a. –0.3 m/s and 0.5 m/s
b. 0.3 m/s and 0.5 m/s
c. –0.5 m/s and 0.3 m/s
d. 0.5 m/s and –0.3 m/s

25. Two particles of masses m_1, m_2 move with initial velocities u_1 and u_2. On collision, one of the particles get excited to higher level, after absorbing energy ε. If final velocities of particles be v_1 and v_2, then we must have: *(2015)*

a. $\frac{1}{2}m_1u_1^2+\frac{1}{2}m_2u_2^2=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2-\varepsilon$

b. $\frac{1}{2}m_1u_1^2+\frac{1}{2}m_2u_2^2-\varepsilon=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2$

c. $\frac{1}{2}m_1^2u_1^2+\frac{1}{2}m_2^2u_2^2+\varepsilon=\frac{1}{2}m_1^2v_1^2+\frac{1}{2}m_2^2v_2^2$

d. $m_1^2u_1+m_2^2u_2-\varepsilon=m_1^2v_1+m_2^2v_2$

26. On a frictionless surface, a block of mass M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed v/3. The second block's speed after the collision is: *(2015 Re)*

a. $\frac{\sqrt{3}}{2}v$
b. $\frac{2\sqrt{2}}{3}v$
c. $\frac{3}{4}v$
d. $\frac{3}{\sqrt{2}}v$

27. A ball is thrown vertically downwards from a height of 20 m with an initial velocity u_0 It collides with the ground, loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity u_0 is: (Take g = 10 ms^{-2}) *(2015 Re)*

a. 10 m/s
b. 14 m/s
c. 20 m/s
d. 28 m/s

28. Two particles A and B, move with constant motion in one dimensional with velocities $\vec{v}_1$ and $\vec{v}_2$. At the initial moment their position vectors are $\vec{r}_1$ and $\vec{r}_2$ respectively. The condition for particle A and B for their collision is: *(2015 Re)*

a. $\vec{r}_1-\vec{r}_2=\vec{v}_1-\vec{v}_2$

b. $\frac{\vec{r}_1-\vec{r}_2}{|\vec{r}_1-\vec{r}_2|}=\frac{\vec{v}_2-\vec{v}_1}{|\vec{v}_2-\vec{v}_1|}$

c. $\vec{r}_1.\vec{v}_1=\vec{r}_2.\vec{v}_2$

d. $\vec{r}_1\times\vec{v}_1=\vec{r}_2\times\vec{v}_2$

Answer Key

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
c	a	b	c	b	c	b	c	a	d	d	b	a	d	d	b	b
18	19	20	21	22	23	24	25	26	27	28						
c	d	d	a	b	b	d	b	b	c	b						